There were performed after admission into the hospital—

Amputations of left leg	1
" " low. 3d thigh	1
" " mid. 3d "	1
" " knee-joint	1
" " trephining	1
Ligature of femoral artery	1

All of which were fatal.

One case of ligature of the carotid (external) was successful.

All these were secondary operations performed from two to six weeks after injury, and all but the cases of ligation of arteries and trephining were in the field hospital, where depressing causes alluded to above existed, and which explains the great mortality.

MURFREESBOROUGH, TENN., Nov. 25, 1863.

ART. IV.—*A Description of some Instances of the Passage of Nerves across the Middle Line of the Body.* By JEFFRIES WYMAN, M. D., Hersey Prof. of Anatomy in Harvard College.

BICHAT appears to have been the first anatomist who pointed out the existence of a communication between the peripheral nerves of the right and left halves of the body. He has not entered into any descriptive details of it, and the substance of what he says may be found in the following words:—

> "Sometimes two nerves of the same pair, or those of two different pairs, but from each half of the nervous system, unite on the middle line, examples of which are seen in the superficial nerves of the neck, in those of the chin, &c. This union does not take place on the abdomen, where the middle line, entirely aponeurotic contains no nervous branches in its tissues. It is, perhaps, by these anastomoses, that the persistence of motion in certain paralyzed parts can be explained. They are, however, quite rare." * * * "If each nerve had them it is evident that hemiplegias could hardly take place, for the healthy side of the brain or of the spinal cord could influence through them the nerves of the diseased side."[1]

Meckel[2] and Beclard[3] subsequently announced similar views with regard to the union of the two valves of the nervous system at certain points, but describe it only in general terms.

---

[1] Bichat, Anat. Gén., t. i. p. 133. Paris, An X. (1801).

[2] Meckel admits three kinds of anastomosis; the first and second are found on one and the same side of the body; the third is between two homonomous nerves from opposite sides, as in the subcutaneous branches of the fifth and of the seventh pairs, or between some of the nerves of the neck.—*Manuel d'Anatomie*, t. i. p. 229. Paris, 1825.

[3] "Anastomoses sometimes take place between branches of the same nerve, sometimes between different nerves, and more rarely between nerves of one side and those of the opposite side."—*Elements of General Anatomy.* Translated by Robert Knox, M. D., p. 346. Edinburgh, 1830.

Cruveilhier, in commenting upon the opinions of Bichat, appears to have misunderstood him, and implies that Bichat asserted the existence of anastomoses along the whole length of the median line ("*les anses nerveuses que Bichat indique sur tous les points de la ligne mediane du corps.*"[1]) We do not find any proof of the correctness of Cruveilhier's impression, either in the passage first quoted, nor elsewhere in the writings of the great French anatomist. Having denied the existence of such communications, Cruveilhier says: "The only anastomoses on the middle line with which I am acquainted, are those of the pneumogastric, behind the lower end of the trachea, that of the two solar plexuses, and that of the cardiac nerves."[2] He, however, omits to add that of the phrenic nerves, of which he makes especial mention on another page.[3]

Vogt, in his account of dissections of the nervous system of reptiles, describes and figures the anastomosis of the hypoglossal, xii., in the tongue of the alligator, *Champsa sclerops.*[4]

Hyrtl, the most accurate and pains-taking of living anatomists, in his description of "endless nerves," notices especially the anastomosis of the right and left hypoglossal in the fleshy portions of the genio-hyoid muscles.[5] Hirschfeld and Leveillé, in their Iconography of the Nervous System, describe and figure the anastomosis of the lingual branch of the trigeminus at the tip of the tongue, also that of the phrenic in front of the pericardium.[6] Many other anatomists have made mention of one or more of these nervous communications, but it is unnecessary to cite them.

Drs. S. Weir Mitchell and George R. Morehouse, in their admirable *Researches on the Anatomy and Physiology of Respiration in the Chelonia,* have shown that the upper laryngeal nerves not only communicate with each other, but form a symmetrical chiasma across the fore-part of the larynx, and have experimentally demonstrated, that by means of this chiasma, each laryngeal nerve exerts an influence over the muscles, both of the same and of the opposite side. In connection with these observations they say, "This remarkable nerve furnishes the only known instance in nerve anatomy of an extra cranial chiasma."

In attempting to verify the results of Drs. Mitchell and Morehouse, we have been led to examine other animals, and find that the chiasma proved by them to exist in the turtles, is present also in the iguana, python, and alligator among reptiles, and among birds in the ducks and geese. As it differs but little, in the animals just mentioned, from that already described in the turtles, a general account of it is all that will be necessary. It should be borne in mind, however, that the movements of the larynx are controlled by a similar set of muscles in all of them, viz., by a pair of constrictors, or arytenoids (Figs. IV. and V., *a*), sometimes so intimately connected as to appear as a single muscle, and a pair of dilators, or crico-arytenoids, exterior to and crossing the preceding in a nearly vertical direction (Figs. IV. and V., *b*). It is, probably, in consequence of this similarity of muscular arrangement that the distribution of the nerves in the larynx is so nearly the same in all.

---

[1] Anat. Descriptive, t. iv. p. 437. Paris, 1845.

[2] Ibid., p. 437.

[3] Ibid., p. 492.

[4] Beiträge zur Nevrologie der Reptilien, p. 44, pl. iv., fig. 2. Neuchatel, 1840.

[5] Nat. Hist. Review, vol. ii. p. 97.

[6] Nevrologie, ou Description et Iconographie du Système Nerveux, par MM. Ludovic Herschfeld et J. B. Leveillé, pl. 41, fig. 2, and pl. 91, fig. 4.

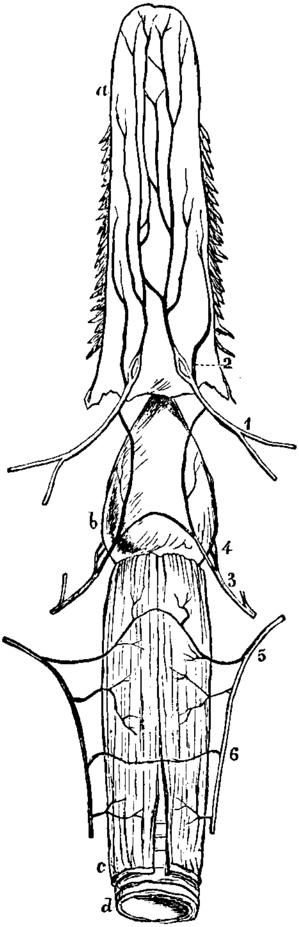
Laryngeal Tracheal Chiasma in Birds.—This has been carefully studied in ducks and geese. In order that it may be fully understood, it will be necessary to begin with a description of the glosso-pharyngeal nerve at the place where it escapes from the cranial cavity. This nerve, as far as it has been examined, when it leaves the cranium receives, in most birds, a large communicating branch from the vagus, which, from the subsequent distribution of the nerve which it joins, and from there being no separate branch corresponding with the upper laryngeal, must be considered as forming, or at least containing, this last mentioned nerve. Near the point where the two nerves are thus united a branch is given off which is directed forwards, and a little lower down a second, which follows the course of the hyoid bone, unites with the preceding (Fig. I., 1), and enters the base of the tongue. In its distribution through the tongue we find a very marked instance of a connection between the nerves of the two halves of the body. As the right and left nerves enter the base of the organ, and after giving off a large branch to the salivary glands (2), the trunks divide into two strands, which almost immediately come together again; each trunk then extends along the whole length of the tongue near the median line, giving branches outwards to the borders, and inwards others, of which about six are continuous from opposite sides across the long axis of the tongue. These nervous communications are oblique, unsymmetrical, and contain numerous nerve-tubes, especially the one near the base, which is much the largest.[1]

The terminal portion of the glosso-pharyngeal (3) after giving a small branch to the œsophagus, passes to the side of the larynx. There the trunk, which must now be considered as consisting wholly of the upper laryngeal, supplies, by its posterior branch (4), the muscles of the larynx and the mucous membrane in and near the glottis; it then becomes united with its fellow by means of a symmetrical but quite slender chiasma. This is smaller than either of the trunks which it connects, and from this circumstance it seems probable that the influence of each nerve on the muscles of the opposite side would be less than on those of the same side. From each angle of the chiasma a slender nerve passes forwards, giving a slender filament to the laryngeal muscles, and at last unites with the lingual branch of the glosso-pharyngeal, 1.

---

[1] In the class of birds generally the glosso-pharyngeal supplies the tongue with all of its sensitive branches, unless there be a few fibres combined with it from the vagus. The lower maxillary branch of the fifth gives off no lingual branch. Among reptiles the same is for the most part true.

Fig. I.



NERVES OF THE TONGUE AND LARYNX IN THE GOOSE.—*a*, the tongue; *b*, the larynx; *c*, the long tracheal muscles; *d*, the trachea; 1, glosso-pharyngeal nerve; 2, branch to the salivary gland; 3, upper laryngeal nerve and decussation; 4, branch to laryngeal muscles; 5 and 6, the two decussations of hypoglossal.

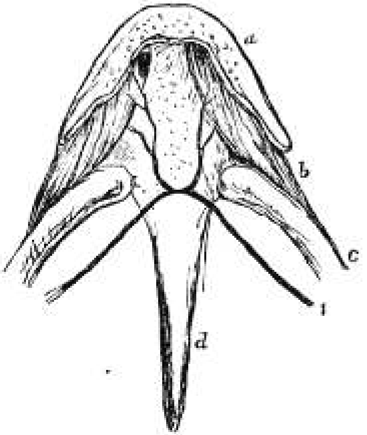
The preceding description is drawn entirely from the goose. In the duck the chiasma of the laryngeal has a similar structure, but the decussations of the lingual nerve are mostly confined to the central part of the tongue. The trunks of the nerve in the forepart of the organ are separated by a fibrous raphé, across which no filaments were traced.

On tracing the hypoglossal nerve to the long muscles on the front of the trachea, decussations of the right and left nerves are easily demonstrated. Two of these are represented in Fig. I. at 5 and 6.

In dissecting from the detached larynx of the African ostrich, the lingual nerve, which, in its distribution, corresponds with, and undoubtedly is, the glosso-pharyngeal, no chiasma was detected in the usual place, though it is possible that it may have been accidentally destroyed in the removal of the organs. The right and left nerves, after having supplied the muscles and mucous surfaces of the larynx, advance to the tip of the tongue, where they anastomose very freely, the two trunks forming a continuous arched nerve across the middle line.

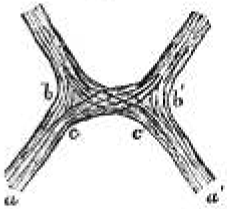
The hypoglossal nerve differs quite remarkably from the same part in the other animals here described. The nerves (Fig. II., 1) following the horns of the hyoid bone (*c*), converge towards the body of it (*d*), and between the bases of the horns, and on the under or fore side of the body, form a very short, but perfectly distinct and symmetrical chiasma, measuring only the one-tenth of an inch in length. From each angle of it a nerve passes forwards, the branches of which are distributed to the muscles of the tongue. This structure and distribution of the hypoglossus in the ostrich resembles that of the same nerve described by Vogt as existing in the alligator.[1]

Fig. II.



TONGUE AND A PORTION OF THE HYOID BONE OF THE OSTRICH.—*a*, a portion of mucous membrane of the tongue; *b*, hyo-glossus; *c*, cornu of the os hyoides; *d*, body of the same; 1, hypoglossal nerve and chiasma.

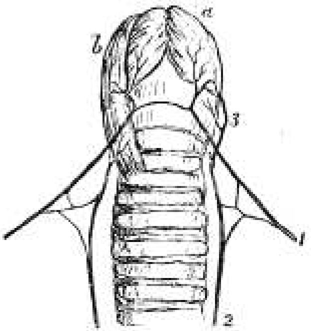
Fig. III.



Chiasma of the hypoglossus in the ostrich.

The chiasma (Fig. III.), when examined under the microscope, is easily resolved into two sets of fibres. Each nerve trunk (*a*, *a'*) divides into two bundles, one of which passes directly forwards to the muscles on the same side (*b*, *b'*), and the other (*c*, *c'*), crosses to the opposite side. As the bundles pass each other in the chiasm, the fibres become somewhat separated and spread out. The number of fibres in the direct and decussating bundles are about the same, therefore the influence of each nerve on the muscles of the opposite, is, undoubtedly, equal to that on those of the same side with itself.

Fig. IV.



LARYNX OF PYTHON.—*a*, constrictor of the glottis; *b*, dilator; 1, upper laryngeal nerve; 2, lower or recurrent nerve; 3, communicating branch between the upper and lower nerves; the left dilator is removed.

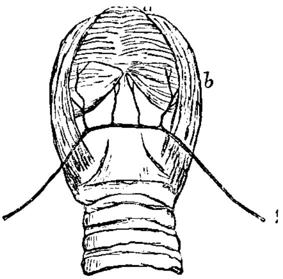
In the Python.—As the larynx upon which this dissection was made had been cut away from the surrounding parts, the connections of the laryngeal with the other nerves were not traced. The recurrent, Fig. IV., 2, and the upper laryngeal, 1, form a small plexus by an interchange of fibres before they reach the larynx. The chiasma between the right and left branches of the upper nerve is much more slender than in either of the other animals here described, and was traced with great difficulty. The terminal branches of the nerve are distributed to both the contractors, *a*, and the dilators, *b*. The recurrent nerve is mainly distributed to the dilators, or crico-arytenoids, as in turtles, but in addition forms a communication with the superior laryngeal by means of a very slender filament, 3, which lies beneath and is concealed by the muscles just mentioned. In this case the chiasma is so slender that it seems improbable that either laryngeal nerve should exercise as much influence on the opposite as on the same side with itself.

---

[1] Ibid., pl. iv., fig. 2.

In the Alligator.—As in the preceding, the dissection was made on a detached larynx. The chiasma is relatively larger than in either of the other instances; is of the same size as the trunks which contribute to the formation of it, and is protected by a very thick sheath of white fibrous tissue; in addition to branches of nerves distributed to the muscles as in the python and the birds, two others are given off near the median line, which perforate the walls of the larynx and are distributed to the mucous membrane within. The recurrent nerve was not traced.

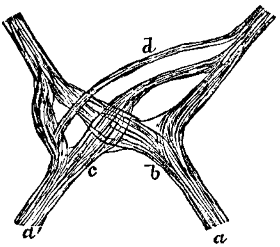
Fig. V.



LARYNX OF ALLIGATOR.—*a*, constrictor; *b*, dilator; 1, laryngeal nerve and chiasma.

Drs. Mitchell and Morehouse have inferred from the crossed influence of the nerves on the muscles of the larynx in the turtle that there is a decussation of fibres. "Part of each nerve probably proceeds directly to the glottic muscles of its own side, while another strand crosses over through the interlateral trunk to be similarly distributed to the two muscles of the opposite side."[1] We have made a microscopic examination of the chiasma of the laryngeal nerve in the iguana (Fig. VI.), and find their inferences fully confirmed; the structure of it being, in its essential features, like that of the hypoglossal nerve in the ostrich. It presented the following irregularity: The fibres from the trunk, *a*, are divided into two strands, one of which passes forwards on the same side, and the other, *b*, crosses in a single mass to the opposite side. Those from the trunk, *a′*, divide into three parcels; one going forwards is separated from the decussating fibres of *a* by an interval filled with fatty matter; a second, *c*, crosses to the opposite side in a manner nearly symmetrical with *b*; and the third, *d*, the smallest, crosses still further forwards. These two comprise all the decussating fibres from *a′* toward *a*. As the bundles *b* and *c* pass each other, their fibres become separated and spread out after the

Fig. VI.



Chiasma of the laryngeal nerve of the Iguana.

---

[1] Researches, p. 35.

manner of nerve fibres in a ganglion. The fibres of *d* pass over the chiasma free. This arrangement gives an unsymmetrical character to the parts, but is most probably only an individual peculiarity.

It appears from what has just been stated that various peripheral nerves from opposite sides of the body form decussations with each other, all of which can be traced by dissection without the aid of the microscope, or at most requiring that of a very low power. The nerves which contribute to such interchanges of filaments are the fifth, the hypoglossus, the laryngeal, and post-tracheal branches of the vagus, the phrenics, and the sympathetic. Drs. Mitchell and Morehouse have demonstrated what had not been previously observed, that in turtles the upper laryngeal nerves form a symmetrical chiasma, to which the right and left trunks equally contribute. Following the lead of their investigations, we have found a similar arrangement in the iguana, python, and alligator, among reptiles, and among birds in the duck and goose, rendering it quite probable that it may be found generally among the two classes of animals just named. We have not found it in the ostrich, and have looked for it without success in a few mammals. We have further ascertained that the hypoglossal nerve of the ostrich forms a chiasma, quite as remarkable as that of the laryngeal in either of the animals which have been previously mentioned in this communication.

The inquiry naturally presents itself here whether these are the only instances, and whether decussations or anastomoses of less size, occurring between terminal filaments of nerves, but too small to be detected, except by the aid of the microscope, do not exist elsewhere on the anterior and posterior median line. We find no notice of such communications in the text-books of histology commonly in use, and no mention of them either in the works of Kolliker, Virchow, or other more recent writers on microscopical anatomy.

To answer the question thus raised we have made our examinations for the most part on the skin of the abdomen, and on the mucous membranes of the roof of the mouth of the frog and the skate. These parts were chosen on account of their thinness, and the absence of pigment, two conditions of great importance to the successful investigation of their minute structure. The parts to be examined were treated in the first instance with dilute nitric acid, in order to make the nervous fibres opaque, then carefully washed in water, and just before being placed under the microscope immersed in a solution of caustic soda. This renders all the other tissues highly transparent. Adopting this method, we have been able to trace, with ease, the course of the nerves through the whole thickness of the skin, without being obliged to have recourse to sections by which the natural arrangement of parts is often too much disturbed to admit of correct study.

The following are the appearances which have been frequently observed in the nerves as the two halves of the peripheral system come together. The different nerve trunks of small size, and of one and the same side, as they approach the median line, interchange fibres very freely, making an intricate plexus, which forms a network not unlike that of the capillary bloodvessels. The nerve-angles which result from the division of a trunk into branches are formed either by two bundles of fibres diverging from each other as in all the larger nerves, or by three, the third bundle passing along one of the branches to the point of separation, and is then reflected off into the other. The fibres of these different bundles become so intermixed that we have found it impracticable to follow them, except for a very short distance, from the angles. In the immediate neighbourhood of the median line the number of fibres in a nerve gradually diminishes, and there may be as many as twelve, or as few as two or three or even one. It is by such as these that right and left halves of the peripheral system are connected.

Fig. VII.

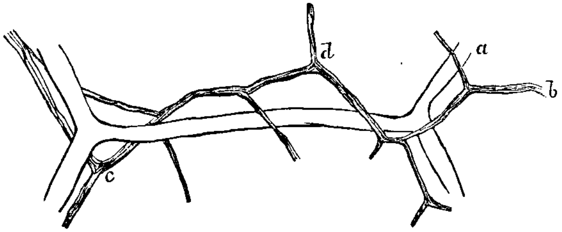
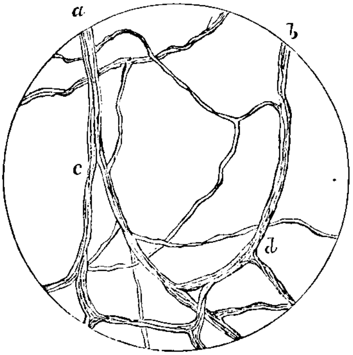


Fig. VII. represents one of these communications between the two sides, seen in the skin of the abdomen of the frog, following, as is very frequently the case, one of the small bloodvessels, *a*; *b*, the trunk of a nerve; *c* and *d*, nerve-angles of three bundles of fibres. Fig. VIII., *a*, nervous plexus from the under side of the head of a skate, *Raia batis; a* and *b*, two nerves, one on the right and the other on the left of the median line; *c*, a nerve-angle of two bundles of fibres; *d*, a nerve-angle with three bundles. Between the two trunks, *a* and *b*, are various communicating branches. The interchange of fibres in this specimen is greater than is commonly the case, especially at the lower part of the figure. Nevertheless we have succeeded in tracing, without difficulty, communications of different degrees of complexity, between the right and

Fig. VIII.



left halves of the nervous system, at almost every point on the roof of the mouth and in the skin of the abdomen in frogs, and in various parts of the integuments of the under side of the body in skates.

Physiological questions of considerable importance grow out of the anatomical conditions described above. The experiments of Drs. Mitchell and Morehouse prove that certain motor fibres actually do cross the median line and influence muscles on the side opposite to that of the half of the central axis from which they arise. The extent of their influence, it is true, is confined within very narrow limits. Have the sensitive nerves an analogous relation to the two sides of the body? May an impression made upon a given point on the skin be carried to the chord across the median line? We are aware of no experiments which give an answer to these questions. The answer from pathology as far as it goes is in the negative. Dr. Copeland expresses himself distinctly in the following words: "The more extended forms of partial anæsthesia generally appear in one half of the body, hemiplegic anæsthesia, and is limited with precision by the median line."[1] It is to be borne in mind, however, that few writers appear to have made the precise limitations of paralysis of sensibility a special subject of study. New investigations are required to enable the physiologist to form a decisive opinion as to whether the boundaries are in all cases so precise.

There is another question which seems to us an appropriate one here. Do the fibres under consideration, or some of them, pass entirely around the front of the body and enter the chord on the side opposite to the one from which they started, and thus come into the category of "endless nerves?" That this supposition is not improbable is shown by the facts, long since established by Volkman, Gerber, J. Müller, and others, that in each lateral half of the body certain nerve-fibres pass out to a greater or less distance from the chord, and then without having become connected with any tissues return to it either on the same or on an adjoining trunk, forming what Henlé calls "nerves without peripheral expansion." The observations of Newport, on the nervous system of articulate animals, show that certain nerve-fibres pass through the ganglion from side to side, having no end. And the more recent observations of Lockhart Clarke, and Deane, demonstrate an analogous fact in the human spinal chord. May not the peripheral system have its analogous loops?

Note.—Since the above communication went to the press we have met with two other instances of a union between the right and left hypoglossal nerves; one in a seal, *Phoca vitulina*, just below the larynx, passing symmetrically across the whole front of the trachea; and a second in the "pinnated grouse," *Tetrao cupido*, where the communication was found in two individuals, and in both made by means of an oblique trunk, descending from right to left, across the trachea just below the larynx, passing, in its course, over several tracheal rings, and thus differing from the other instances in having an unsymmetrical arrangement.

---

[1] Med. Dictionary, article Paralysis, vol. vi. p. 13, American edition.

The following citations may be added to those already given:—

Bach (*Annotationes Anatomicæ de Nervis Hypoglosso et Laryngeis, Dissertatio Inauguralis*, Turici, 1834) states that, in the dissection of thirty-two human bodies, he found between the genio-hyoid and genio-glossus muscles, an anastomosis of the right and left hypoglossal nerves three times.

Cloquet (*Traité d'Anatomie Descriptive.* Paris, 1828, t. ii. p. 129) describes a communication between the right and left laryngeals in the mucous membrane of the interior of the larynx; also one between the non-palatine nerves in the foramen incisivum.

T. Miller (*Berlin Transactions*, 1835) describes the anastomosis of the organic nerves on the dorsum of the penis.

Art. V.—*On the Disease produced by the Trichina Spiralis.* By Wm. Keller, M. D., of Darmstadt, formerly of Philadelphia.

The comparative frequency in Germany of the recently discovered disease produced by Trichina, has induced me to collect the following facts in regard to it:—

Discovery of Trichina Spiralis.—Mr. T. Hilton, Demonstrator of Anatomy at Guy's Hospital, found, in 1832, in dissecting the body of an old man, who had recently died of a cancerous affection, a large number of small white bodies, dispersed in the substance of the voluntary muscles. On a close examination he found them to consist of oval calcareous cysts. He first described them in the *London Medical Gazette*, in 1833, vol. xi. p. 605. He believed that the cysts belonged to a new class of intestinal animals, and were of no important consequences to the human system. In 1835, Mr. R. Owen found a small filiform animal in the capsule (a fact which Mr. J. Paget, then a student, had already suspected). Considering the animal a new one, he called it Trichina spiralis. By careful examination, the animal will be found more or less frequently in the dissecting-room. At first, the Trichina spiralis was considered as quite low in the animal scale; but afterwards, on a closer examination, a mouth, stomach, intestine, anus, and even perfect genital organs were observed. Some naturalists regarded them as perfectly organized animals; but the majority, misled by the discoveries of Siebold and Dujardin in 1844, believed them